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Authors: De Panizza, A
Bogdanowicz, M

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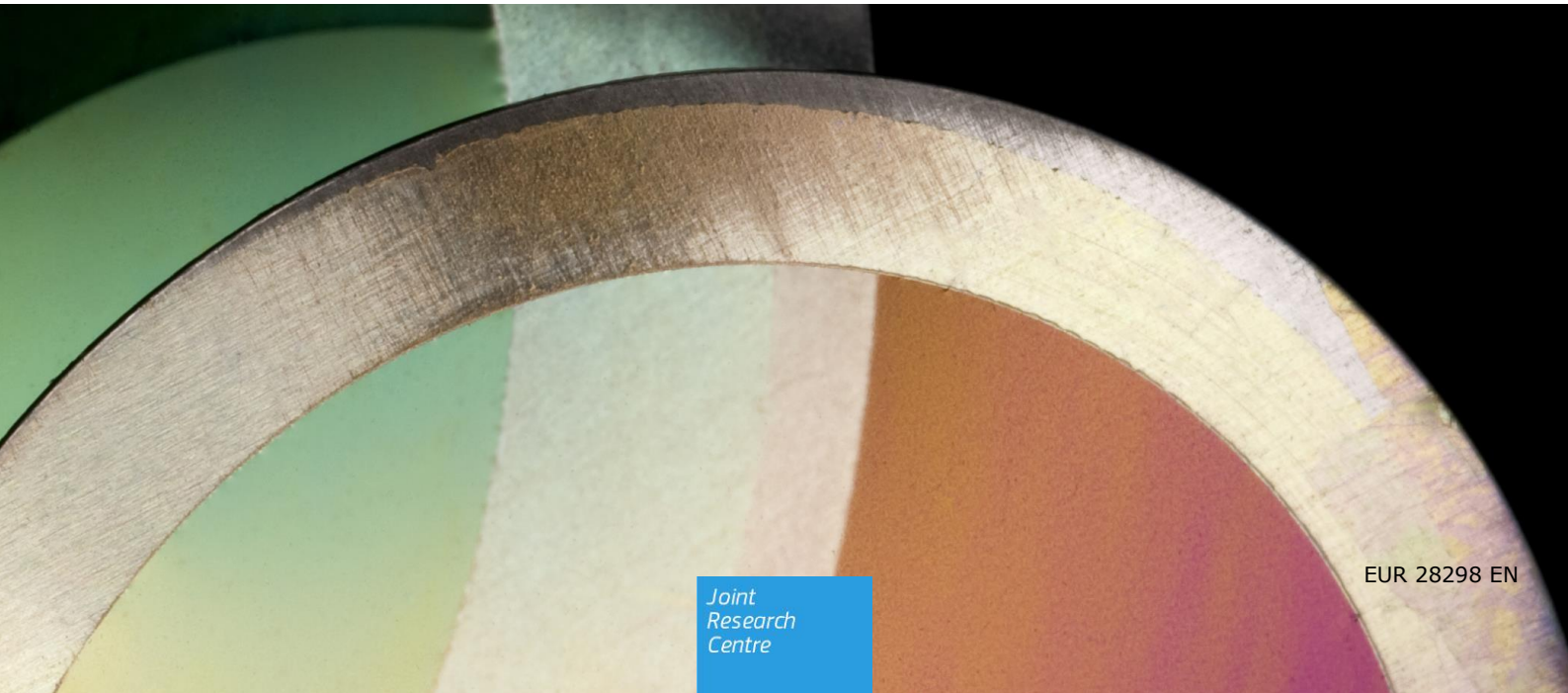

EUR 28298 EN

Joint Research Centre

Contact information
European Commission, Joint Research Centre
Address: Edificio Expo. c/Inca Garcilaso, 3. 41092 Seville (Spain)
E-mail: b06-sec@jrc.ec.europa.eu
Tel.: +34 954488318

JRC Science Hub
https://ec.europa.eu/jrc

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Abstract

The PREDICT project focuses on analysing the supply of Information and Communications Technologies (ICT) and Research and Development (R&D) in ICT in Europe, with comparison to major competitors worldwide. The PREDICT 2016 dataset covers data from 40 countries, which contribute to most of the world's ICT production and R&D. It is based on available data for the period 2006 – 2013 from official sources such as Eurostat, the OECD and National Statistics Offices. The data have been prepared using the 2007 OECD definition of the ICT sector, based on the International Standard Industry Classification (ISIC 4). This report offers a condensed graphic presentation of the dataset. To portray the global, European and national ICT industry, the Key Facts report presents four essential variables: Value-added, Employment, Productivity and Business Expenditures on R&D (BERD) of the ICT sector. The report is structured under four headings: Key Facts 1: Global trends in the ICT industry; Key Facts 2: Benchmarking EU in the World; Key Facts 3: Benchmarking EU28 Member States; and Key Facts 4: Industry specialisation patterns. Each part of the report investigates the dynamics of these variables from a different perspective and looks at the relationships between them. It describes the main trends observed: the resilience of the sector throughout the crisis, the emergence of ICT services, the evolution of productivity and R&D expenditures, and the new global division of labour.

A brief introduction to main findings

1. PREDICT report and data coverage

This Report portrays the global features and dynamics of the ICT sector and its R&D, focusing on the performance of the EU and its member states.

The ICT sector comprises a very diverse and yet tightly connected aggregate of industries in manufacturing and services. In the operational definition adopted to allow for international comparability, these include:

- The ***manufacturing*** of *computer equipment*, *telecommunication equipment* (infrastructures as well as personal devices), *consumer electronics* and *electronic components*.[1]
- ***Telecommunications*** (wired, wireless and satellite) and ***computer related activities*****:** software, computer programming, consultancy and related activities as well as information services (data processing, hosting and web portals and other information services).[2]

The report relies on official statistics collected and estimates performed within the PREDICT project.

- **The variables analysed** include value added, employment, productivity and R&D performance in individual ICT industries and in an array of other industries, as well as international trade in ICT products.3
- **The countries surveyed by PREDICT** include: the EU and the 28 EU members, Norway, Russia and Switzerland in Europe; China, India, Japan, Korea and Taiwan in Asia; the United States, Canada and Brazil in the Americas; and Australia.

National currencies are converted into Purchasing Power Standards (PPS), an accounting unit based on current euros, to net for the effect of differences in price levels across countries and of movements in exchange rates.

Adjusting for differences in price levels, these countries account for almost ¾ of world GDP and 90% of global Businesses Expenditure in Research and Development (BERD). They also originate more than 80% of total exports of ICT products.

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[1] These correspond to the Groups 261 to 264 within Division 26 of the ISIC rev. 4 classification of economic activities. The *comprehensive* definition formulated by the OECD (2007) also includes the manufacturing of *magnetic and optical media* (Group 268) which, however, has a relatively low weight. Data for this group are available in the PREDICT database only for EU and few other countries.

[2] In the International standard classification of economic activities (ISIC, rev. 4), these include Group 582 (Software publishing) within Publishing activities Div. 58), the whole Divisions 61 (Telecommunications), and 62 (Computer programming and other related activities), as well as group 631 and class 6399 in Information Services (Division 63).
The broader aggregate of Information and Communication industries (section J, corresponding to Divisions 58 to 63 in ISIC rev. 4) would also include *media and content* service activities.
The *comprehensive definition* of the ICT sector provided by the OECD (2007) also includes the wholesale trade of the above goods and services. Data for these latter activities, as well as for retail trade of ICTs are provided in the PREDICT database for EU member states and a limited number of other countries.

[3] Statistics and indicators produced under the PREDICT aegis provide fine grain information on ICT and media and content industries (disentangled into up to 22 economic activities, 14 of which at the *class* level – i.e. at 4 digits in the ISIC classification), and at a higher level of aggregation for all the other industries in the economy. PREDICT also produces data on Government financing of R&D (GBAORD-GBARD) by socio-economic objectives, and total R&D expenditure at the country level. Now-casting of more relevant data in these domains is also being performed.

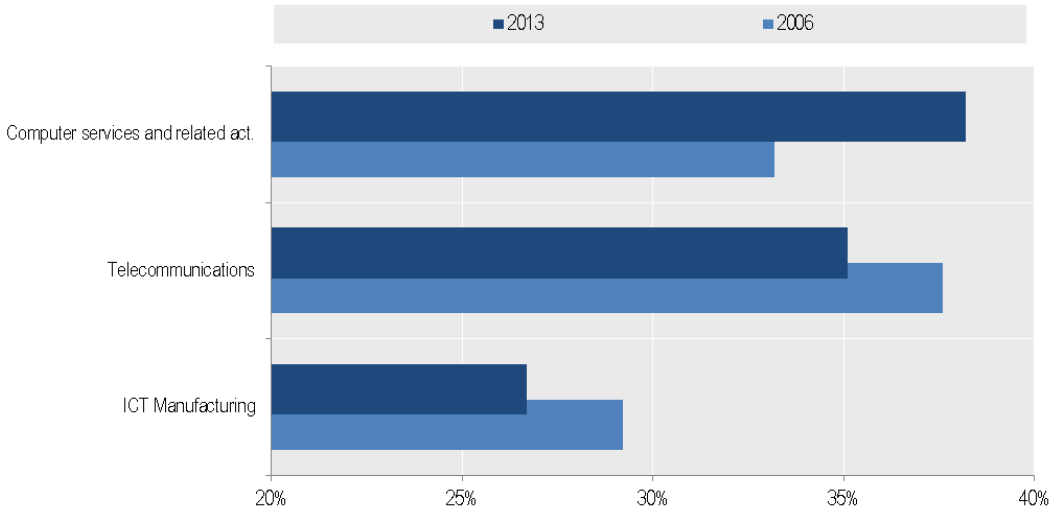
2. The relevance of the ICT sector and its composition

As detailed in the further pages of this Report, in 2013 the value added of the ICT sector in the countries surveyed by PREDICT was nearly 2.6 trillion PPS, corresponding to about 4.5% of their GDP. ICT industries accounted for almost one quarter of the total BERD performed in these countries, pointing at the prominent role of ICT activities for knowledge based competitiveness. Also, with an employment just over 38 million (about 2% of the total), labour productivity was more than twice the whole economy average, reflecting the high capital and R&D intensity of ICT industries.

These shares and levels have been roughly stable over the past years. However, there has been a remarkable shift among industries and in the position of individual countries, as shown in the remainder of the report. In 2013, Computer services and related activities represented 38.2% of the sector's total value added, with an increase of 5 points with respect to 2006. This share was followed by Telecommunications at 35.1% and ICT manufacturing at 26.7%, each losing 2.5 percentage points in the same period (Figure 1).

Figure 1: Relative size of main industry aggregates in value added of the ICT sector: PREDICT countries, 2006 and 2013

Percentage shares



Note: Data refer to the 40 countries surveyed by PREDICT, aggregated from values converted in Purchasing Power Standards (PPS). Industry aggregates and the total refer to the operational definition of the ICT sector, which excludes the wholesale trade of ICT products and minor industries (see footnotes 1 and 2 above). Data for Canada and Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

These dynamics reflect to a large extent the impressive fall in unit prices of ICT manufacturing and telecommunication services,[4] so that the steady increase in the diffusion of ICT products and mobile communications translated in more modest increases in value added at current prices: +13% and +6.5% respectively from 2008 to 2013, adjusting for purchasing power differences across countries, against an increase of more than 25% for Computer services. These latter – typically more labour intensive and, in part, addressing domestic demand – priced better, and also benefitted from the

[4] In the EU28, for instance, the consumer price index for telecommunication services went down almost 15% between 2006 and 2013.

emergence of new activities such as cloud computing, the *app ecosystem,* or data analytics.

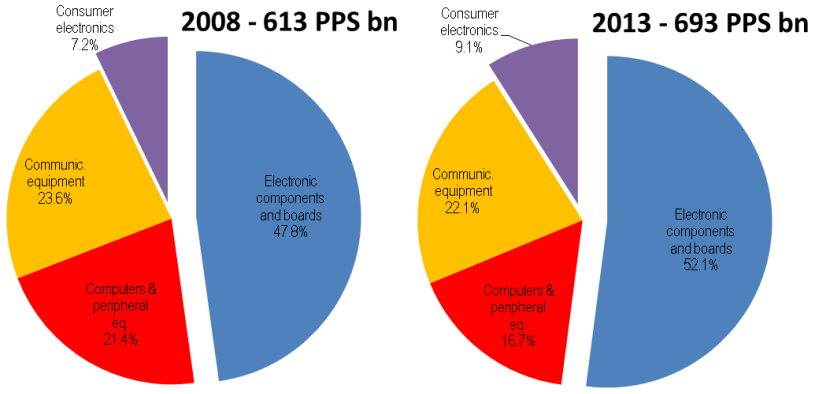
These trends are mirrored in international trade. In 2014, the global contribution of ICT products to merchandise trade and of ICT services to service exports were both about 10%. However, for ICT goods there was a contraction from almost 15% in 2008, while for ICT services there was a gain in share of more than 3 percentage points in the same period.

Within both Information (IT) and Communication Technologies (CT) services, shares of individual activities in value added were relatively stable in the years 2008 to 2013. Computer programming and consultancy are by far the largest aggregate in IT services, with a weight of nearly 72% over total value added in 2013, rising slightly.[5] Within CT services, PREDICT information on individual activities is limited to the EU, the United States, China and Norway: for these countries altogether, in 2013 wired telecommunication services were still prevailing over wireless, with a share of about 58% in the subsector value added, less than one percentage points below the level of 2008.

Within ICT manufacturing value added, instead, from 2008 to 2013 the share of intermediate ICT goods (electronic components and boards) increased 4.3 percentage points to 52.1%, while the weight of equipment (both computers and communication) manufacturing diminished from 45% to 38.8%, slightly diminishing also in value terms, notwithstanding the huge increase in the spread of handheld devices (tablets, smartphones). To some extent this change reflects a shift in demand, considering that components are indispensable for ICT products but nowadays also embedded into most other manufactures, from machineries to cars to children's games. On the other hand, this might as well reflect changes in the allocation of added value in global value chains, with a higher share of the final value of equipment going to the providers of intermediates with respect to final assemblers (Figure 2).

Figure 2: Shares of individual industries in Total value added of ICT manufacturing: all PREDICT economies, 2008 and 2013

Percentage values



Note: data for Canada and Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

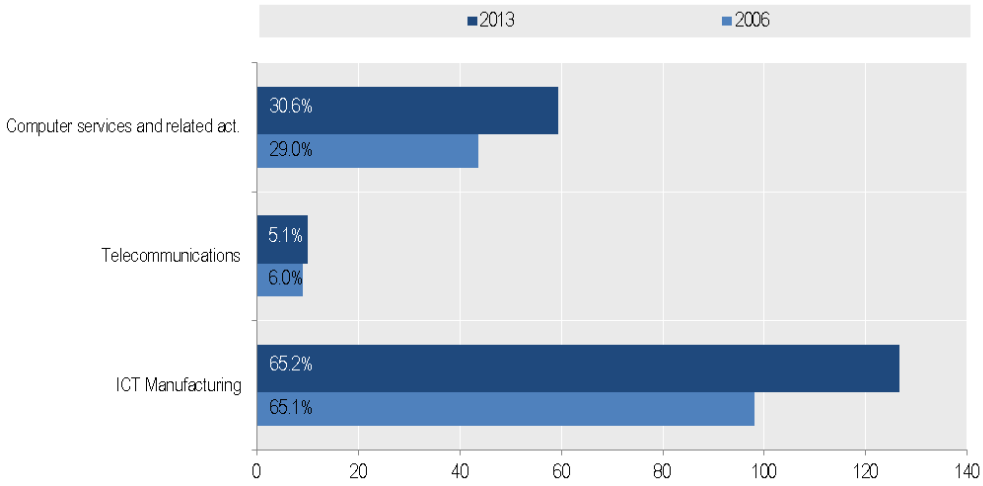
As we shall see in the report, the landscape of ICT sector Business Expenditure in R&D is very diverse from that of value added. In this case, indeed, Manufacturing activities

[5] This share is computed excluding China and Japan, for which such disaggregation is not possible,

continue to lead by far, with a weight of approximately 65%, followed by IT services with about 30% and Telecommunications with a mere 5%. These percentages have changed only slightly over time (Figure 3).

Figure 3: Relative size of main industry aggregates in BERD of the ICT sector: PREDICT countries, 2006 and 2013

Values in PPS bn and percentage shares of the total



Note: Data refer to the 40 countries surveyed by PREDICT, aggregated from values converted in Purchasing Power Standards (PPS). Industry aggregates and the total refer to the operational definition of the ICT sector, which excludes the wholesale trade of ICT products and minor industries (see footnotes 1 and 2 above). Data for Canada and Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Within manufacturing activities, however, a shift occurred in BERD similar and even broader than for the case of value added: indeed, from 2008 to 2013 the share of the industry of electronic components increased almost 10 percentage points, to 51.4%, and consumer electronics also increased their share to 6.6% (Figure 4). This means that the production of components has become considerably more R&D intensive, although the highest level of the BERD/value added ratio can still be found for the case of Communication equipment.

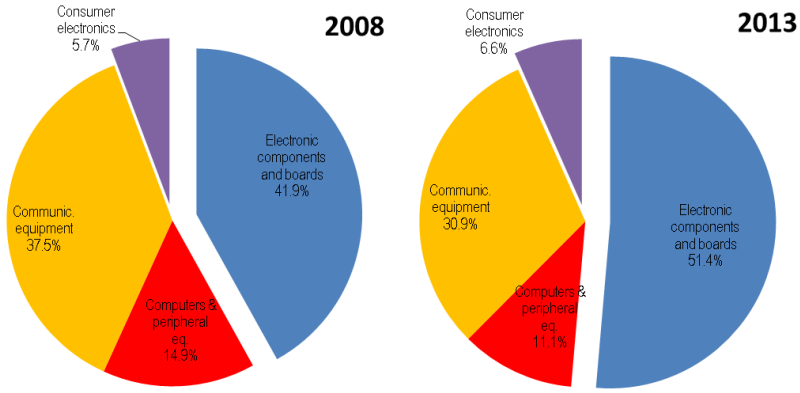
Finally, as we shall see in the Report, these developments are intertwined with the dynamics of specialization and performance of individual economies. In very broad terms, the shift towards IT services was headed by the group of the most advanced economies (the USA, Europe, Canada, Australia, Japan), where internal demand from other industries was stronger. Korea and Taiwan, instead, reinforced their specialization in Manufacturing, while Europe lost its already weak one. During these years, most manufacturing activities were displaced to production hubs in low income or emerging economies. However, some of them (notably, China) started to own part of the process of production and perform specific R&D, thus managing to improve the level of their participation in value added generation, while new ones with very low income levels – for instance, Vietnam – appeared as pure assemblers.

In broad terms, the USA continue to be the largest global player, with a share in the value added of the ICT sector generated by PREDICT economies combined above 25% if adjusted for purchasing power parities and of 30% at current prices and exchange rates (Figure 5). The corresponding shares in the sector's BERD stand at about 40 and 44%. The USA keeps a higher than average specialization in ICTs: the sector weights 5.2% in GDP (against about 4.5% across PREDICT countries) and more than 32% in BERD (up

from 30.5% in 2006, and against a PREDICT average of 24.3%), and productivity is also extremely high and keeps growing (above 160 thousand PPS per worker in 2013, against 68 thousand on average, and little less than 94 thousand in the EU).

Figure 4: Shares of individual industries in Total BERD performed in ICT manufacturing: all PREDICT economies, 2008 and 2013

Percentage values

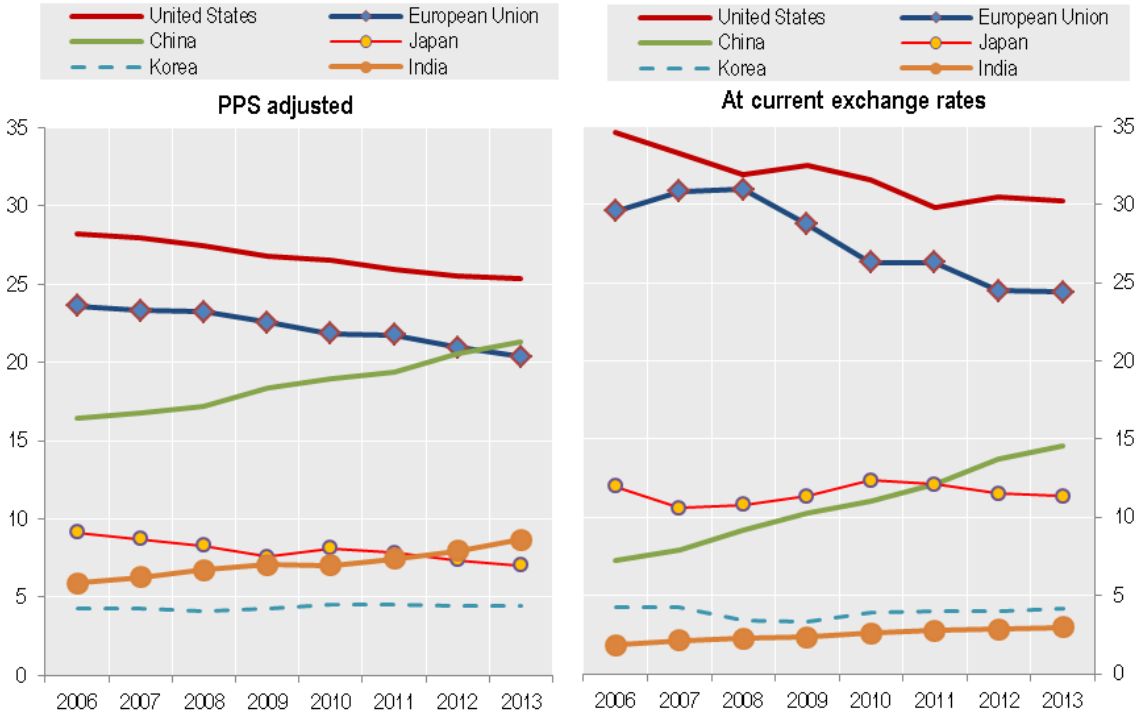


Note: Brazil and Switzerland are not included. Data for India and Russia used in computation refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 5: Shares individual countries in ICT sector value added of PREDICT economies combined, 2006-2013

Percentage values



Note: Operational definition of the ICT sector. For Japan, data refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

The EU follows, with a share of 25% in value added and 16% in BERD at current exchange rates, but falls behind China when correcting for differences in price levels. The EU has lost ground to the advantage of emerging economies much more than the USA did in both respects. Indeed, the EU ICT sector underperformed in value added as well as in BERD and productivity, which stagnated over the period in exam. This reflects the relatively weak overall economic performance across the crisis – the share of the ICT sector in GDP stood still at about 4% - but also the difficulties of the ICT manufacturing subsector, which impacted on the lower engagement in ICT BERD (the sector's share from 2006 to 2013 diminished from 18.2 to 16% of EU total). The sluggish economic performance impacted also on the demand for and the development of computer service activities, while value added in Telecommunications was reduced by increased competition.

On the other hand, the European performance ought to be regarded as an intense transformation occurring in difficult years. Computer services were resilient to the crisis, and some new areas of specialisation emerged (e.g. videogames and web portals) where the EU is strong or leading. Also, as the upcoming PREDICT 2017 database will show, available information points at a continued development of the ICT content in the economy, as portrayed by *real* investment in ICT infrastructures and intangible assets (software and databases), or by ICT employment in the economy, to a large extent outside the ICT sector itself.

Database and Methodological notes

- To access the PREDICT Database and Methodological notes click here.
- The complete database can be seen here in one single Excel file.

Key Facts 1: Global Trends (2006 – 2013)

1.1 Value Added

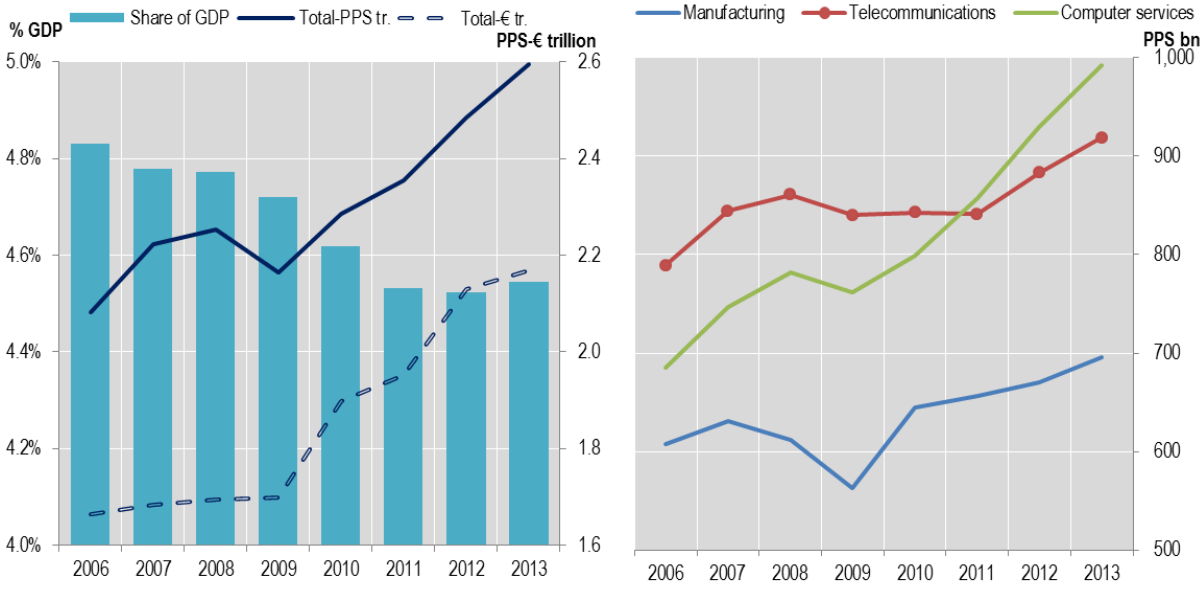
In 2013, the ICT sector of the 40 countries surveyed by PREDICT generated a value added close to 2.6 trillion PPS (or about 2.2 trillion euros), which corresponds to about 4.6% of the total GDP of these 40 countries.

At current prices, the value added generated by the ICT sector increased by 5% from 2012 to 2013. More recent information suggests that global growth in the ICT industries slowed in 2014 and that there was a new upturn in 2015, largely due to growth in software and emerging service activities.

Computer services recovered quickly from the crisis and experienced the strongest growth. Since 2011, they have also become the largest of the ICT industries. Their added value approached 1 trillion euros in 2013. As regards Telecommunications, their overall growth was slower, due to their sluggish or even negative growth in advanced economies (see: The EU28 and the World – Value Added).

Figure 6: Value added of the ICT sector and constituent industries – All PREDICT economies combined (2006-2013)

ICT sector (PPS and euro trillions, and % of GDP, left) and ICT industries (right, PPS billion)



Note: Operational definition of the ICT sector. Canada and Japan: 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

1.2 Employment

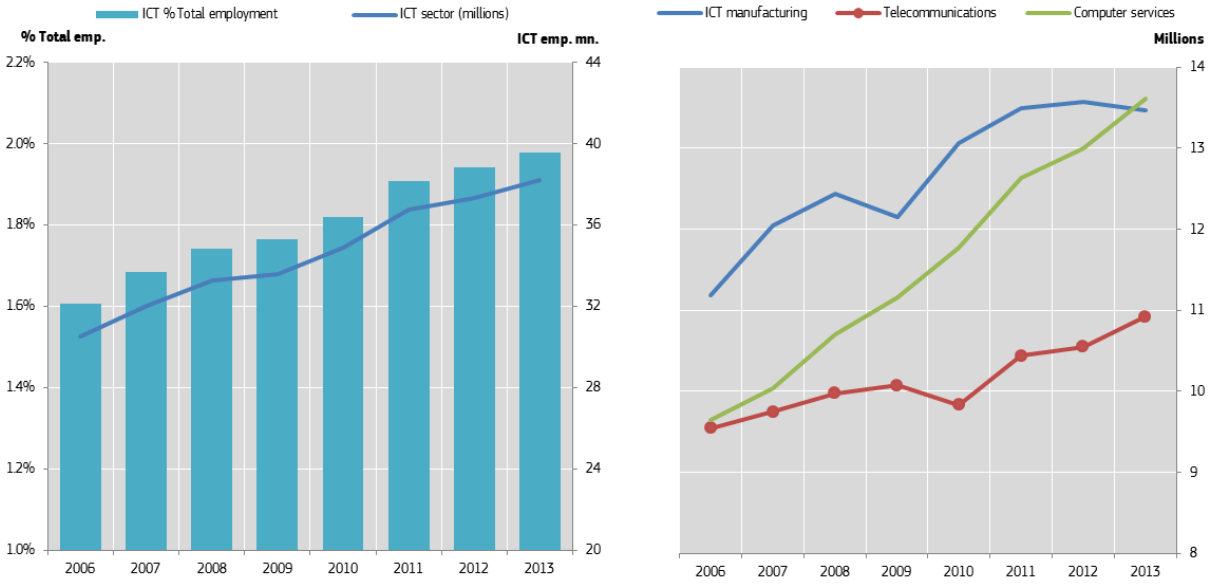
In 2013, the ICT sector in the 40 countries surveyed by PREDICT employed 38 million people, with a yearly increase of 2.4%, as against 0.6% for the whole economy. ICT sector employment was resilient to the crisis and grew during the whole period 2006-2013, increasing its weight from 1.6% to almost 2% of total employment (equalling 1.93 billion people).

Over this period, employment grew in all three ICT sector industries and particularly in Computer Services, which employed 13.6 million workers in 2013 (an increase of 4

million over 2006),. Indeed, Computer Services overtook ICT Manufacturing, where employment diminished in 2013, albeit slightly, for the first time since 2009.

Figure 7: Employment in the ICT sector (left) and constituent industries (right) – All PREDICT economies combined (2006-2013)

Percentage shares in total employment and millions of persons employed



Note: Operational definition of the ICT sector.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

1.3 Labour Productivity

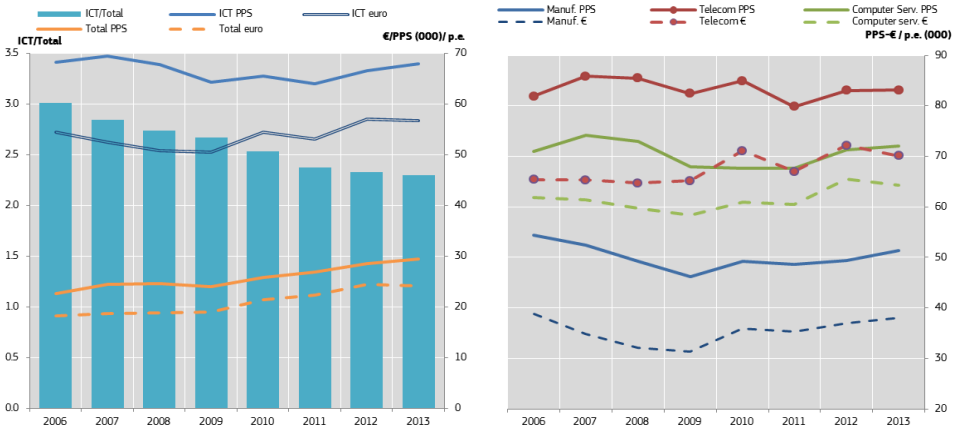
In 2013, the level of value added per person employed in the ICT sector in the 40 countries surveyed by PREDICT was about 2.3 times that of the whole economy, down from 3 times in 2006. This reflects the stagnation of nominal labour productivity in the ICT sector industries over the past few years. Meanwhile in the economy as a whole, it has increased by about 30% since 2006.

In 2013, labour productivity at current prices in the ICT sector stood at 68 thousand PPS per worker (close to 57 thousand euros). It ranged from nearly 85 thousand PPS in Telecommunications (more capital intensive) to just above 50 thousand in ICT Manufacturing, where it was below the 2006 level due to the rapid fall in unit prices and the displacement of production towards low wage economies.

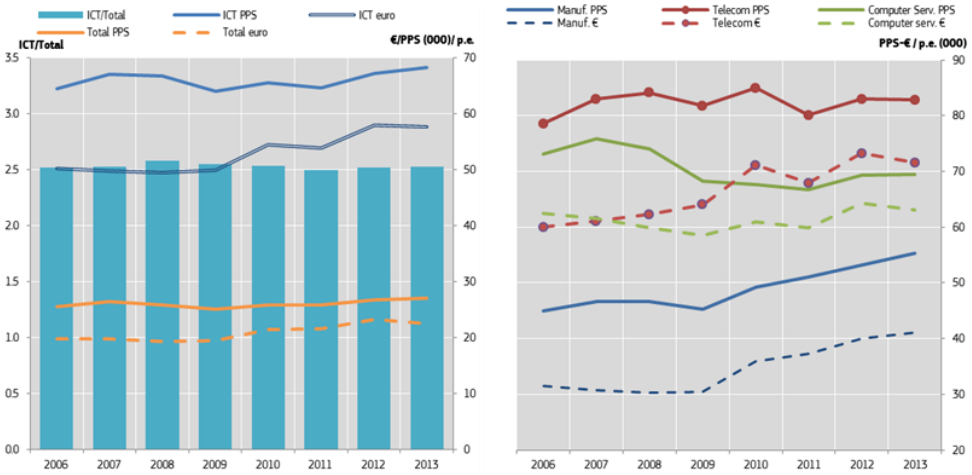
On the other hand, the *volume* measure of value added per person employed from 2006 to 2013 increased by about 10% in both the ICT sector and the economy as a whole. The performance of the different ICT sectors varied. For example, productivity stood still in Computer Services and grew by 20 to 30% in ICT Manufacturing (depending on whether we adjust for cross-country differences in price levels or not). This growth reflects technology advances, competition on unit prices and quality improvements.

Figure 8: Value added per person employed in the ICT sector and constituent industries – All PREDICT economies combined (2006-2013).

Ratio vs. the total economy and values in thousand euros and thousand PPS at current prices



Ratio vs. the total economy and values in thousand euros and thousand PPS at the prices of 2010



Note: Operational definition of the ICT sector. Canada and Japan: 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

1.4 Business Expenditure in R&D (BERD)

In 2013, the ICT sector R&D expenditure in the 40 countries surveyed by PREDICT was close to 200 billion PPS (175 billion euros). This corresponds to about 24% of the total BERD of this group of countries, which account for about 90% of global BERD.

Both in PPS and euros, ICT BERD has grown about 30% in nominal terms since 2006, against about 45% for total BERD, diminishing 3 percentage points in share. In 2013, though, ICT BERD in current PPS increased 7% (down to 1.3% in euro terms, due to currency appreciation), a much higher rate than both total BERD and GDP growth, reflecting a possible rebound.

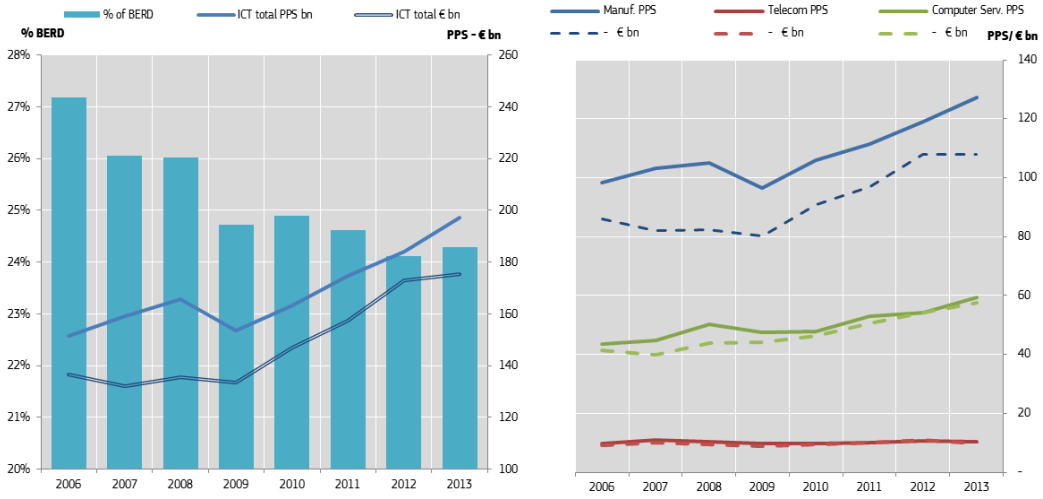
ICT Manufacturing still has a considerable lead in ICT BERD. However, over the past few years, BERD in Computer Services grew faster than it did in both ICT Manufacturing and

Telecommunications. This reflects the shift in the composition of the ICT sector towards these activities (see: Global Trends - Value Added).

The R&D intensity (defined as BERD over value added) in the ICT sector increased smoothly over the 2006-2013 period and continues to be remarkably high compared to the rest of the economy. Levels and dynamics of R&D intensity by industry within the ICT sector are also very diverse and, in part, related to the evolution of their value added.

Figure 9: BERD in the ICT sector and constituent industries – All PREDICT economies combined (2006-2103)

Percentage shares over total BERD (left) and Billions of Euros and PPS (right), 2006-2013



R&D intensity: BERD as a percentage of value added

Note: Operational definition of the ICT sector. VA data for Canada and Japan refer to 2012 instead of 2013. BERD data for Brazil refer to 2008 instead of 2006 and to 2011 instead of 2013. BERD data for India and Russia refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

1.5 Focus on Emergent Activities in Computer Services

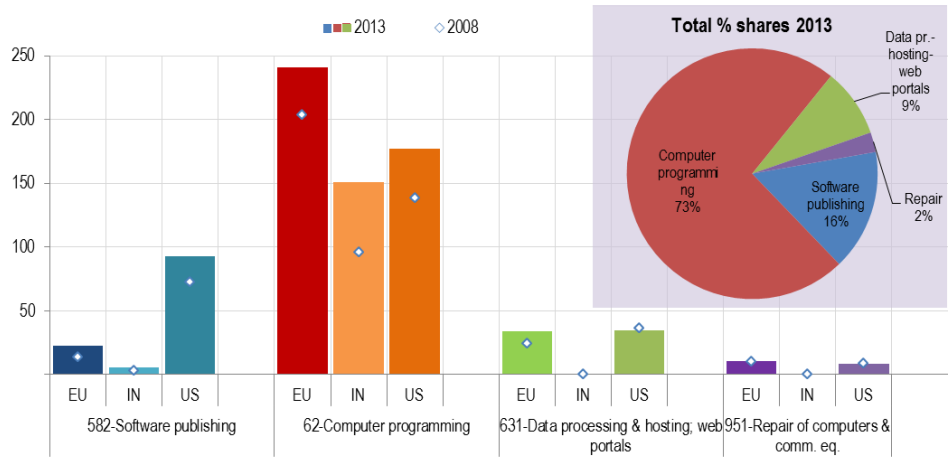
Computer services include a heterogeneous set of economic activities. The growth of Computer Services in many variables observed above justifies specific efforts to capture a first insight into the composition of this aggregate.

As regards aggregated Computer Services, the largest global players are the USA, Europe and India. While the USA is far ahead in software publishing, the EU28 leads in computer programming activities, which represent about ¾ of the total value added of the whole aggregate. Computer programming is the area in which India has been gaining most ground.

In the EU28, the fastest growth was recorded in software publishing (particularly in the games industry), and in web-based platforms.

Figure 10: Computer Services in the EU28, India and the USA (2013 and 2008)

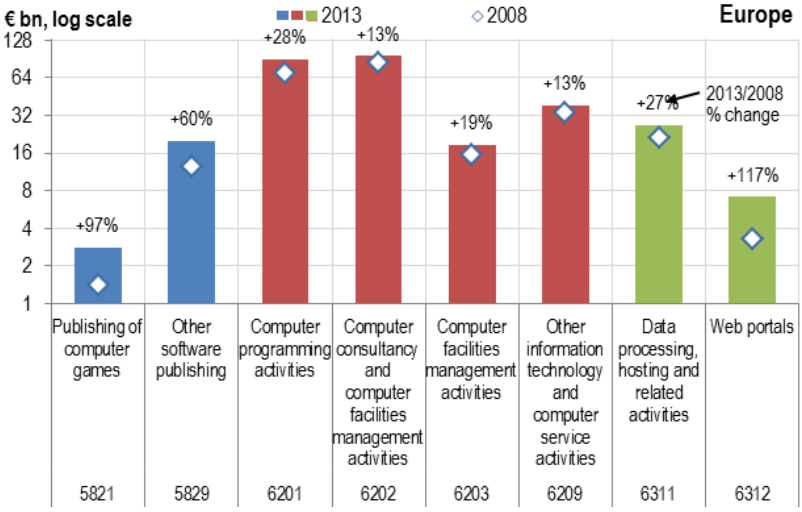
Values in billion PPS and % shares over total for the three economies combined



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 11: Value added of *Computer Services* by ISIC rev. 4 group in the EU28 (2013 and 2008)

Values in billion euro and % increase at current prices



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Key Facts 2: The EU 28 and the World (2006 – 2013)

2.1 Value Added

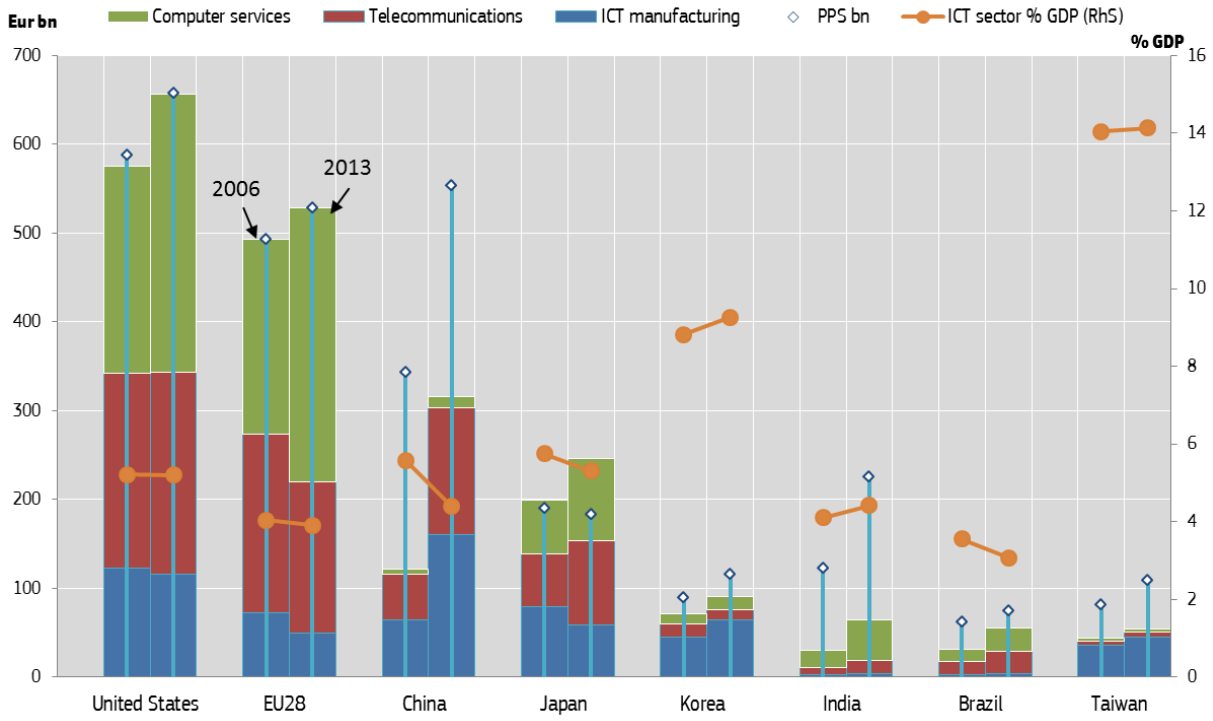
The **USA** leads worldwide with an ICT sector value added close to 660 billion euros in 2013**.** The ICT sector value added in the **EU28** comes second at about 530 billion euros (above 580 billion euros if ICT wholesale trade and manufacturing of magnetic and optical media are included). The increase at current prices of value added in the EU28 was 1.4% in 2013 (far above GDP growth) and even higher growth is expected for 2015.

Since the beginning of the crisis in 2008, value added in the EU has grown considerably less than that of its competitors. In particular, value added in **China** and **India** continued to increase and, when price differences have been adjusted for, both overtook the EU and **Japan** (◇ PPS billion in Figure 7).

The composition of the ICT sector is very diverse across countries. The EU, the USA and India specialise in Computer Services while China, Korea and Taiwan specialise in ICT Manufacturing. Korea and Taiwan are also the only countries which have reinforced their overall specialisation in the ICT sector (measured as % in GDP, **o—o** in chart). These dynamics have in turn an effect on global trade (see forthcoming PREDICT 2017 report).

Figure 12: Value added of ICT industries – EU28 and the main world producers (2013 and 2006)

Values in billions of euros and PPS, and Percentage shares of GDP



Note: Operational definition of the ICT sector. Data for Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

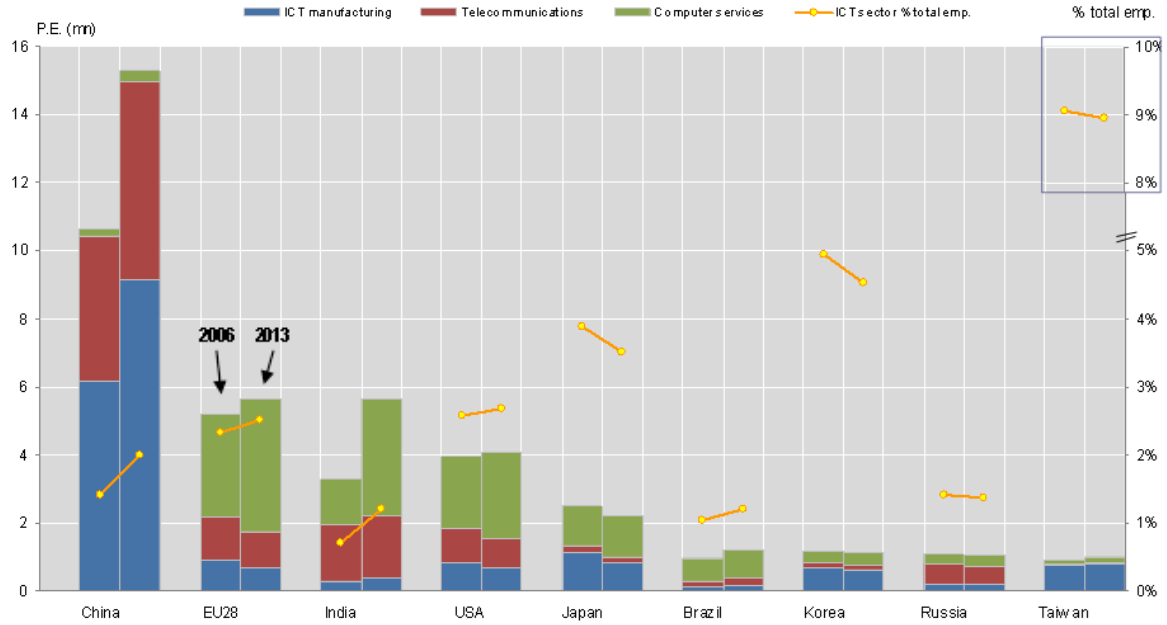
2.2 Employment and Productivity

China is by far the largest ICT sector employer. It employed more than 15 million people in this sector in 2013 (up 44% since 2006), of which almost 9.2 million work in ICT Manufacturing activities (this amounts to almost 70% of the total number employed in ICT Manufacturing in the 40 PREDICT countries together). Overall labour productivity in China has doubled in terms of purchasing power and tripled in euros at current prices, albeit starting from an extremely low level. Labour productivity in the ICT sector is about twice as much as it is in the total economy, although its growth was slower (about 100% in euro terms).

The **EU28** comes second and employs 5.6 million people (up 9% since 2006). ICT sector employment has increased from 2.3% to 2.5% of total employment, or 2.8% if we use the ICT sector comprehensive definition.[6] In Europe, employment growth occurred only in the comparatively labour intensive activities related to Computer Services, up 900 thousand to 3.9 million (see: Global Trends - Focus on Emergent Activities in Computer Services). In contrast, numbers employed in ICT Manufacturing declined from more than 900 thousand in 2006 to fewer than 700 thousand in 2013. The overall dynamics of labour productivity in Europe were subdued through the crisis period. Levels slightly decreased in the ICT sector (from 95 to 93 thousand euros, still about 55% higher than the total economy), due to both the rising weight of Computer Services and the fall of productivity in ICT Manufacturing and Telecommunications (see: Benchmarking EU28 Member States – Employment and Productivity). Computer Services are also the most important and fastest growing employers in India, the USA, Japan and Brazil.

Figure 13: Employment in ICT industries – EU28 and the main World producers (2006 and 2013)

Millions of persons employed and percentage shares in total employment



Note: Operational definition of the ICT sector.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

[6] The comprehensive definition also includes the manufacture of magnetic and optical media (ISIC rev.4 code 268) and the wholesale of ICT products (ISIC rev.4 code 465). See footnotes 1 and 2.

In **India,** employment in Computer Services in 2013 was 1.6 times that of 2006, reaching 3.5 million. Hence, India became an important player in the IT services industries and the third economy in the world ICT employment ranking.

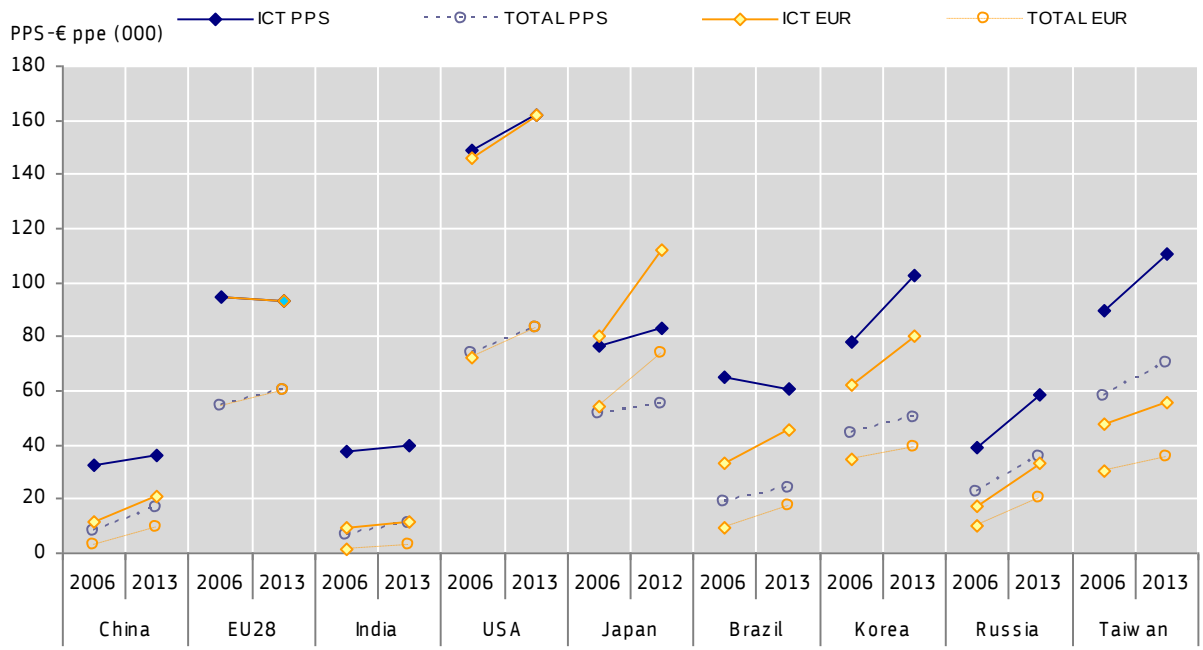
The USA maintains its leading position in the value chain with a smaller employment base. This and the fact that it grew more strongly than Europe, and that its ICT Manufacturing base is still robust are mirrored in the high and growing levels of labour productivity in ICT industries.

In **Japan**, on the other hand, employment fell almost 30% (from close to 1.1 million to just over 800 thousand) in ICT Manufacturing, resulting in a drop of total employment in the ICT sector. This in turn affected favourably labour productivity as the value added of ICT industries stagnated in PPS (and continued to grow in euro terms due to currency appreciation).

Korea and especially **Taiwan**, managed to maintain their very large employment base in ICT Manufacturing, and experienced high productivity gains. Indeed, with the exception of Korea, Taiwan and Japan, in all countries the dynamics of value added in the ICT sector was more employment intensive (and less reliant on productivity growth) than that of the total economy.

Figure 14: Labour productivity in ICT industries and in Total economy – EU28 and the main World producers (2006 and 2013)

Thousand PPS and thousand euros per person employed

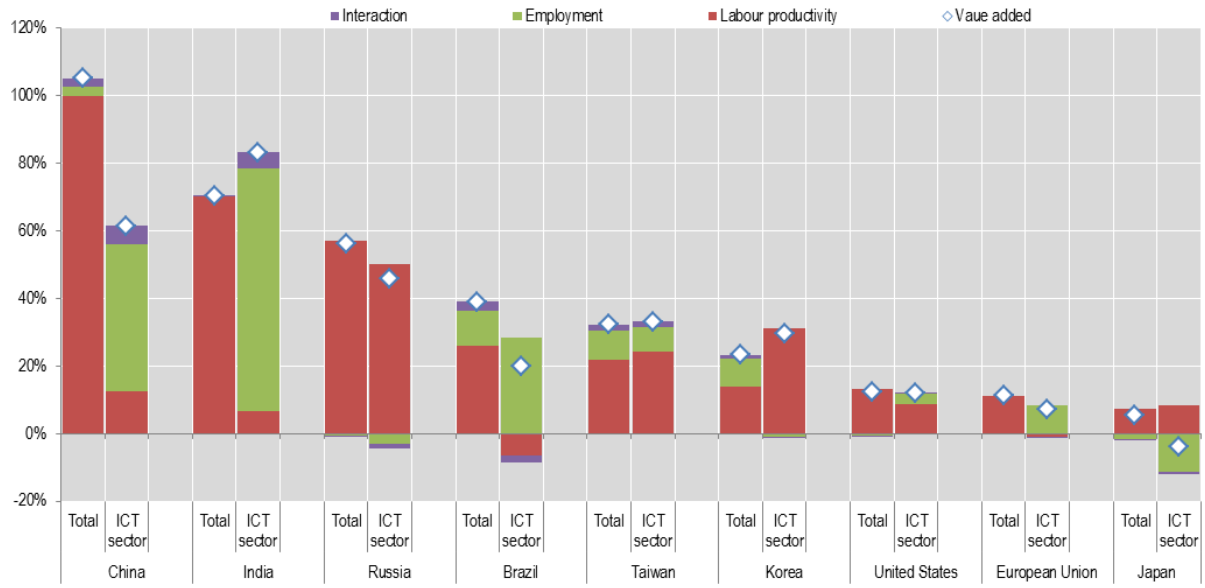


Note: Operational definition of the ICT sector. VA data for Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 15: The dynamics of Value added and the contributions of employment and labour productivity changes. Total economy and the ICT sector – EU28 and the main World producers (2006 and 2013)

Percentage values



Note: Operational definition of the ICT sector. VA data for Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

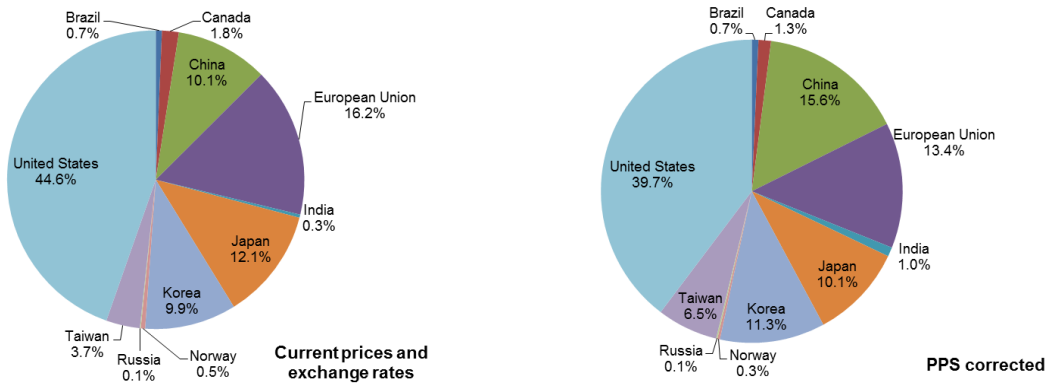
2.3 Business Expenditure in ICT R&D (ICT BERD):

The **USA** carries out the most ICT industrial R&D, and spent 78 billion euros in 2013 (45% of the PREDICT countries' total spend and 30% more than in 2006). The USA is comparatively specialised and 32% of its total BERD is spent on ICT R&D. The **EU28** follows some distance behind, spending barely 28 billion euros. It grew much more modestly over the period, due to the fall of BERD in ICT Manufacturing (see: Benchmarking EU28 Member States – ICT BERD). This phenomenon was even more apparent in **Japan,** leading to a fall of 9 percentage points to 21.5% in the share of ICT BERD since 2006. Conversely, R&D in ICT Manufacturing increased substantially in **China, Korea** and **Taiwan**. In China this was accompanied by much faster BERD growth in other industries, while in Korea and Taiwan ICT industries generated the majority of BERD and their specialisation in ICT R&D has continued to grow over the last few years.

Figure 16: Business expenditure in R&D (BERD) of ICT industries – EU28 and the World leading ICT R&D performers (2006 and 2013)

Values in billions of euros and PPS, and percentage shares over total BERD

Percentage shares over ICT BERD in the PREDICT aggregate, 2013



Note: Operational definition of the ICT sector. Data for Brazil refer to 2008 instead of 2006 and to 2011 instead of 2013. Data for India and Russia refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Key Facts 3: Benchmarking EU28 Member States

3.1 Value Added

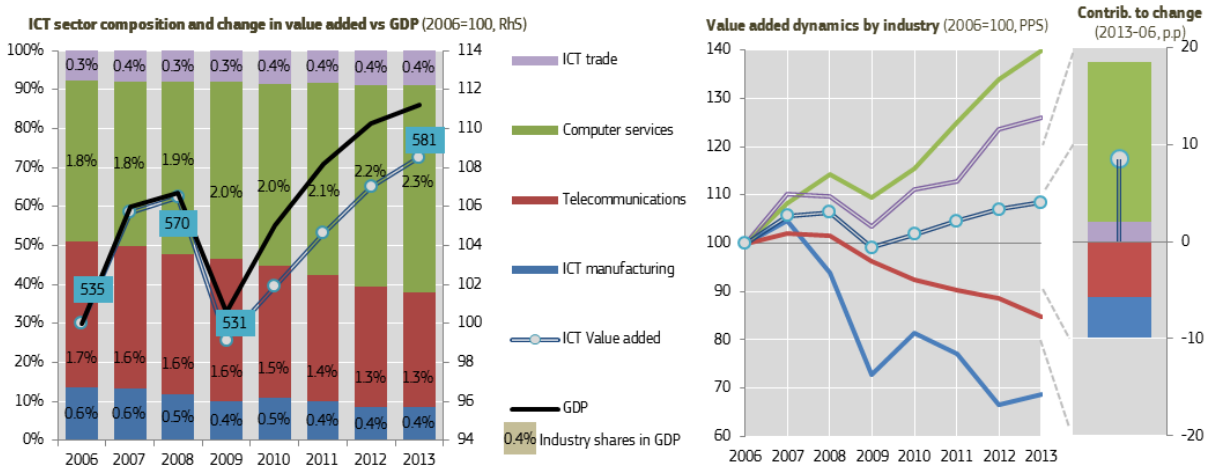
In the EU28, the ICT sector share in the economy remained almost unchanged over the period (in 2013: about 4.3% of GDP, against 4.4% in 2006) (Figure 13). This apparent stability conceals very large changes at the industry level (Figure 12). Indeed, since 2006, the value added of ICT Manufacturing activities at current prices diminished by about 30%, and that of Telecommunications by about 15%, while value added of Computer services increased by nearly 40%, accounting for more than half of the ICT sector total.

Available information suggests that in 2014 and 2015 value added of ICT Manufacturing activities rebounded. In Computer services, it expanded further, while in Telecommunications, it was still losing ground.

At Member State level, data show heterogeneous dynamics for the ICT sector as a whole (Figure 13) but similar by-industry trends – i.e. ICT Manufacturing and Telecommunications lost ground, whereas Computer services gained (Figures 14, 15 and 16 below). From 2006 to 2013, the ICT sector performed fairly well in Germany and the UK (although not in euro terms), and contracted slightly in Italy and France. ICT value added of the ICT sector grew considerably (but not always the sector's share, as some non-ICT industries grew faster) in countries such as Bulgaria, Estonia, Ireland, Luxembourg, Latvia, Poland, Romania and Slovakia. It contracted, however, in Finland and Greece (-40% and -23% respectively from 2006 to 2013).

Figure 17: EU28 – ICT sector composition, by industry value added and contributions to change, 2006-2013

Percentage values



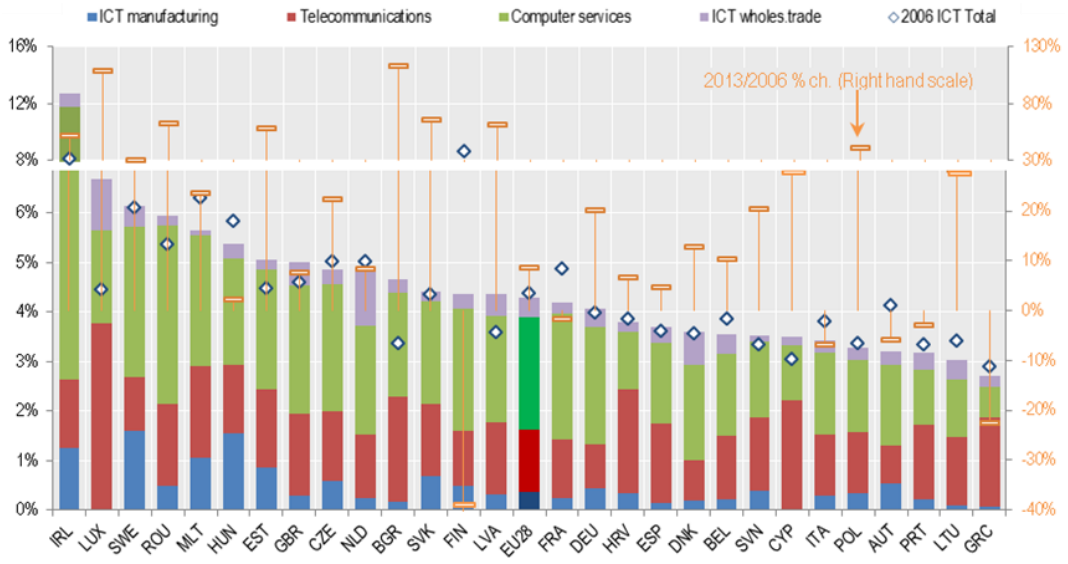
Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

VALUE ADDED in ICT Manufacturing went down everywhere except in a few *production hubs* located in the Eastern and Baltic Member States. Nonetheless, ICT Manufacturing continued to contribute 1.2-1.5 percentage points to the GDP of Sweden, Hungary and Ireland (against less than 0.4% for the EU28 as a whole). In Ireland, France, Austria and Belgium, ICT Manufacturing shrank by approximately 50%, and by as much as 85% in Finland.

The top EU players (Figure 15) include the largest economies (except Spain) and Sweden. Germany alone holds a share of almost 25%, followed at a distance by the UK, Sweden, Italy and France. The share of the UK, Sweden and Italy in the EU total

increased over the period 2006-2013, only because the fall in their ICT Manufacturing value added was limited.

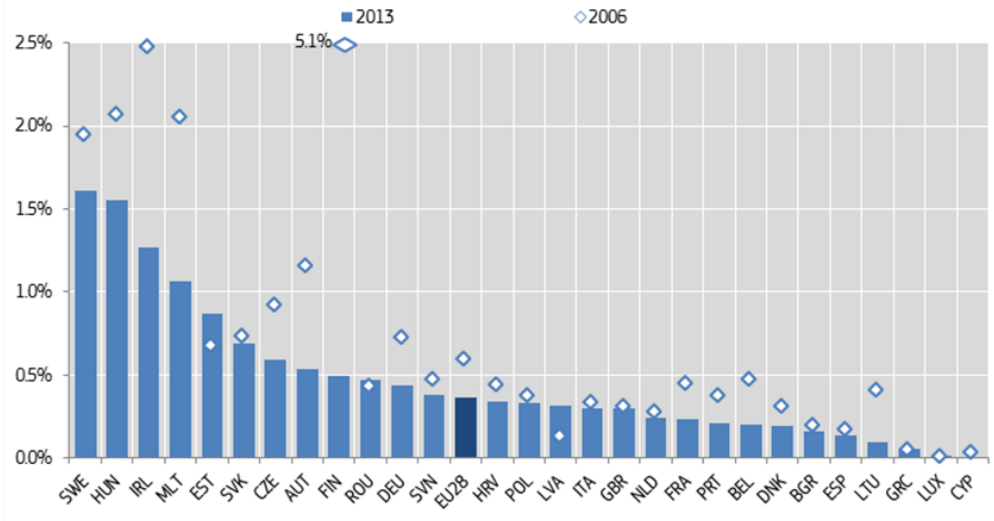
Figure 18: EU Member States – percentage shares of the ICT sector and constituent industries in GDP, 2013 and 2006



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 19: Relevance of ICT Manufacturing activities in EU28 Member states, 2013 and 2006

Percentages over GDP



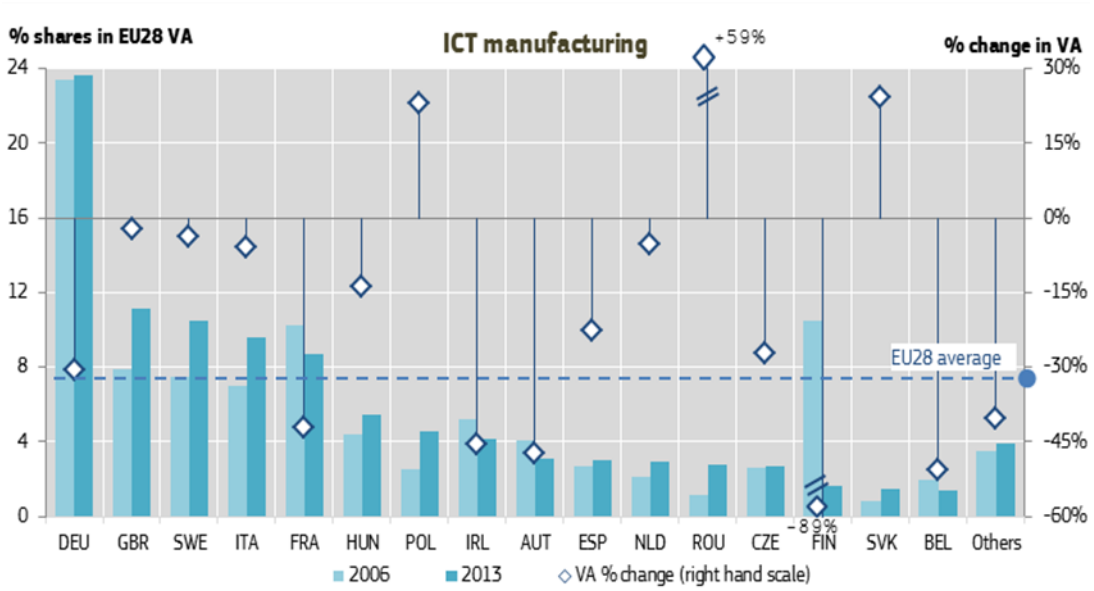
Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

VALUE ADDED in Telecommunication services: Telecommunication services has performed poorly over the past few years almost everywhere, with value added at current prices increasing only in a few Member States, In Germany, Italy, Greece, Austria, Hungary and the Czech Republic it fell by about 30%. In general, this tendency reflects increased competition and, in some cases, might also be due to the spin-off (de-integration) of service activities (e.g. call centres) by telecom operators.

The size of telecommunication service industries depends on various factors, including population size and population density (respectively directly and inversely related to the need for infrastructure), income (increasing the demand for high-end services), the international presence of domestic operators, and competition. The five largest Member States contribute about 70% of the EU total value added (Figure 17). In this group, the UK managed to increase its share to almost 20%, overtaking Germany, due to its very strong international position in mobile communications.

Figure 20: Top EU28 Member states in ICT Manufacturing value added, and value added dynamics by country, 2013-2006

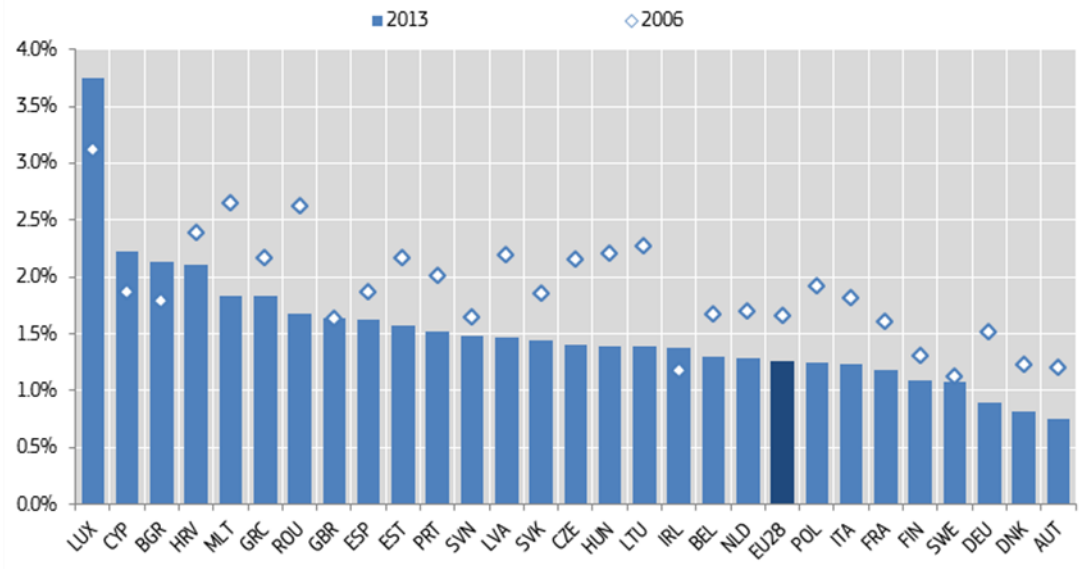
Percentage shares and percentage changes



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 21: Relevance of Telecommunications activities in EU28 Member States, 2013 and 2006

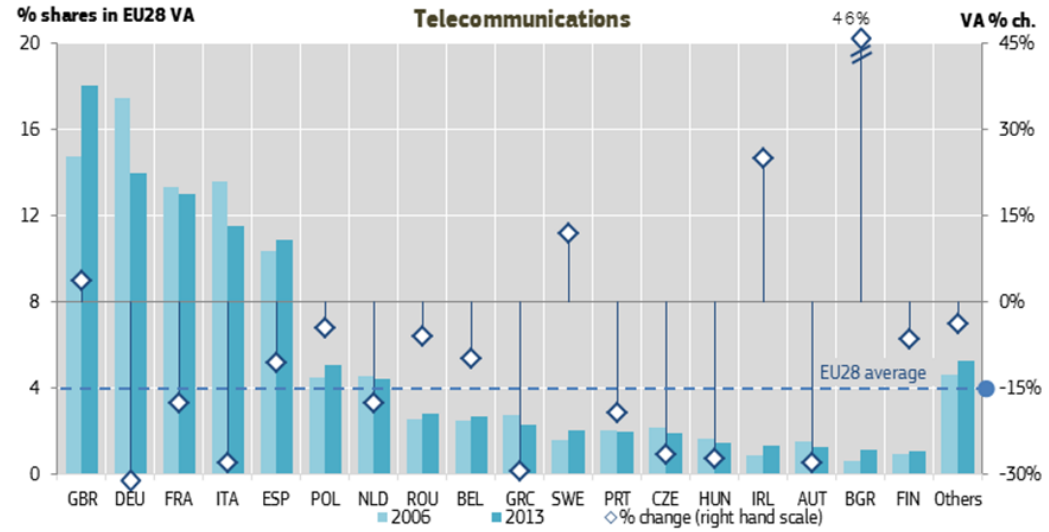
Percentages over GDP



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 22: Top EU28 Member States in Telecommunications value added, and value added dynamics by country, *2013-2006*

Percentage shares and percentage changes



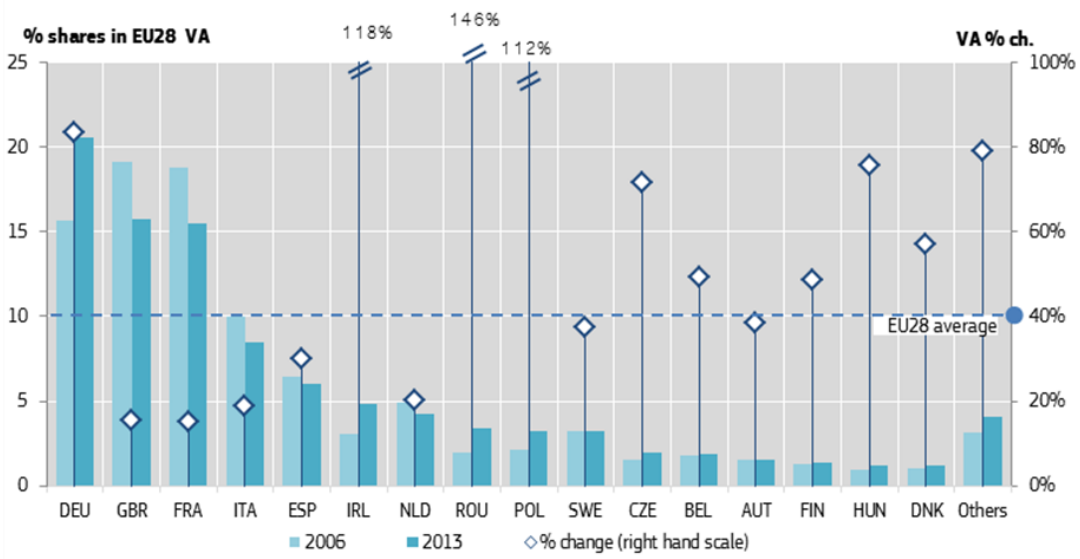
Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

VALUE ADDED in Computer services and related activities has been steadily growing in recent years across all Member States. The domestic nature of Computer service activities renders home markets particularly important. Therefore the size of the domestic economy influences the size and development of Computer services, with Germany gaining shares and becoming the largest player, followed by the other large EU economies: the UK, France, Italy and Spain.

On the other hand, many small and medium-sized economies recorded striking increases, including Ireland, Romania, Poland and several smaller countries. In Ireland, the weight of Computer services increased from about 4% to more than 9% of GDP.

Figure 23: Top EU28 Member states in Computer services value added, and value added dynamics by country, 2013-2006

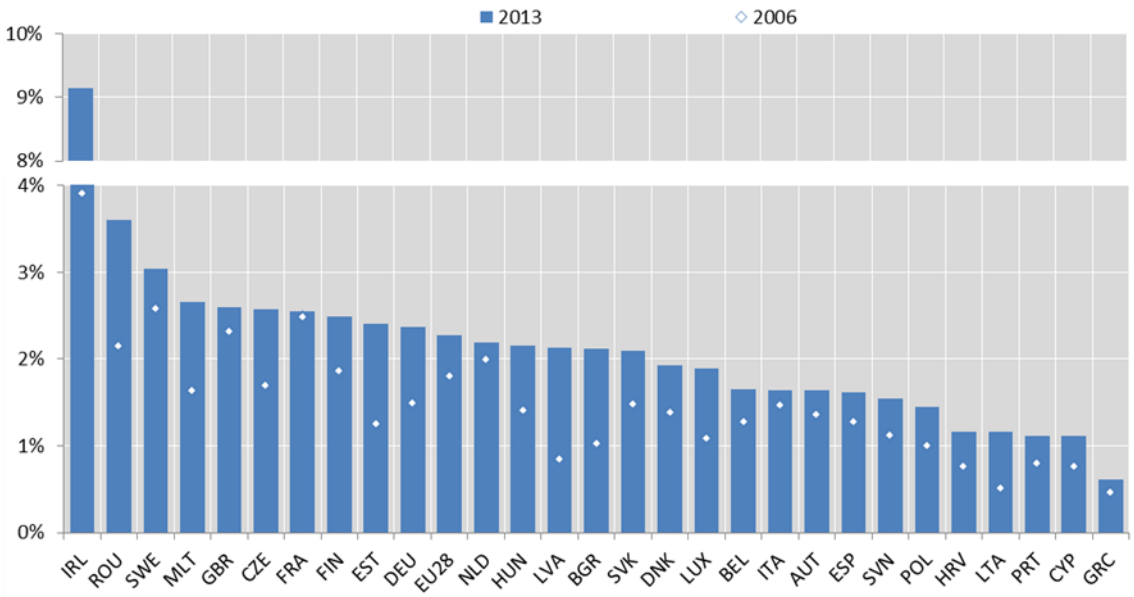
Percentage shares and percentage changes



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 24: Relevance of Computer services and related activities in EU28 Member states, *2013 and 2006*

Percentages over GDP



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

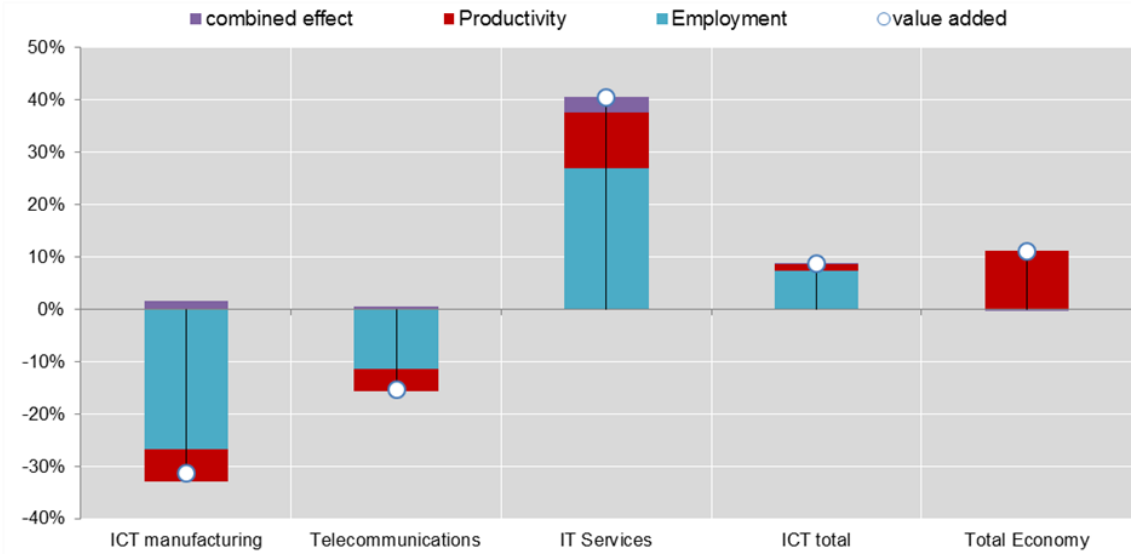
3.2 Employment and Productivity

In individual ICT industries, this moved in the same direction as value added, at least in nominal terms (Figure 20). In practice, in Telecommunications and ICT Manufacturing activities, the contraction of value added was larger than the loss of employment. As a result, productivity also dropped. This was compensated for only partly by the positive performance of Computer services, and it explains the sector's overall modest growth in productivity vs. the whole economy recorded for the EU28.

It is worth noting that the ICT sector growth in added value is driven more by employment than by labour productivity compared to the average of the EU28 or non-EU economies. National dynamics (Figure 21) follow a similar pattern, with levels of productivity and changes reflecting the level of per capita income and industrial specialisation of individual economies.

Figure 25: The determinants of value added dynamics in ICT industries and in the total economy in the EU28

Percentage points contributions of employment and labour productivity changes, 2013-2006



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 26: Value added per person employed in EU countries. ICT industries (2013) and ICT sector (2013 and 2006),

Thousand euros at current prices, log scale

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

3.3 ICT BERD in the EU28

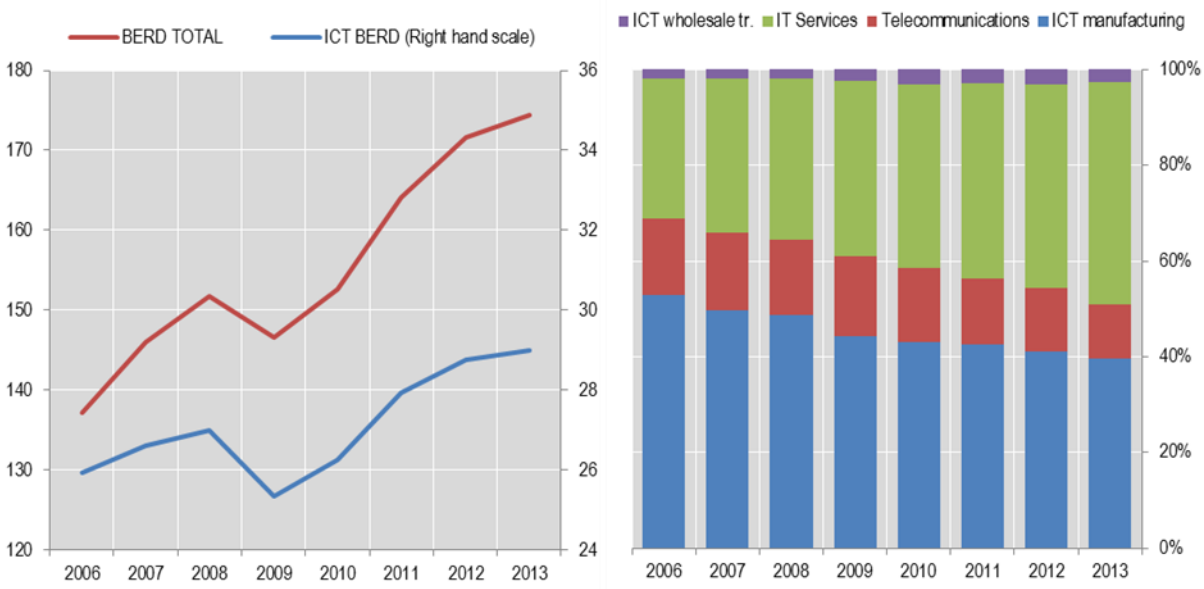
This was about 29 billion euros in 2013, putting the EU28 second, but far behind the USA (see: The EU28 and the World – ICT BERD). This level is slightly above that of 2012. For some years, R&D in the ICT sector grew less than total BERD, so that its share in industrial R&D eroded progressively, from almost 19% in 2006 to 16.6% in 2013. Underlying this smooth downward trend was a very important inter-industry shift, which roughly reflected the dynamics of value added. R&D expenditure in ICT Manufacturing, which in 2006 represented nearly 55% of ICT BERD, contracted about 15% until 2013 and BERD performed by Telecommunication industries diminished more than 20%. On the other hand, R&D in Computer services and related activities grew almost 80% from 2006. In 2013, this aggregate represented almost half of ICT BERD.

In the EU, some Member States have very high R&D intensity (defined as the ratio of BERD to value added) in the ICT sector: i.e. the Nordic economies, France, Germany and Belgium. With the exception of Denmark, these countries are characterised by a comparatively high share of ICT Manufacturing activities in ICT BERD performance, and the same occurs with some followers (Slovenia and Italy). Germany, France, Sweden and Italy also increased their contribution to the EU28 total ICT BERD.

Finland, on the other hand, lost ground due to its ICT Manufacturing crisis, although it remains specialised in ICT R&D and ranks first in R&D intensity. ICT BERD also went down in the United Kingdom – once a leader in the EU – probably reflecting the externalisation of part of its ICT R&D activities, as had already happened with production. Finally, domestic ICT productive hubs in the Baltics and Eastern Europe are now increasingly hosting R&D activities, albeit starting from very low levels of intensity.

Figure 27: ICT BERD in the EU28: comparative dynamics vs. total BERD and by industry composition, 2006-2013

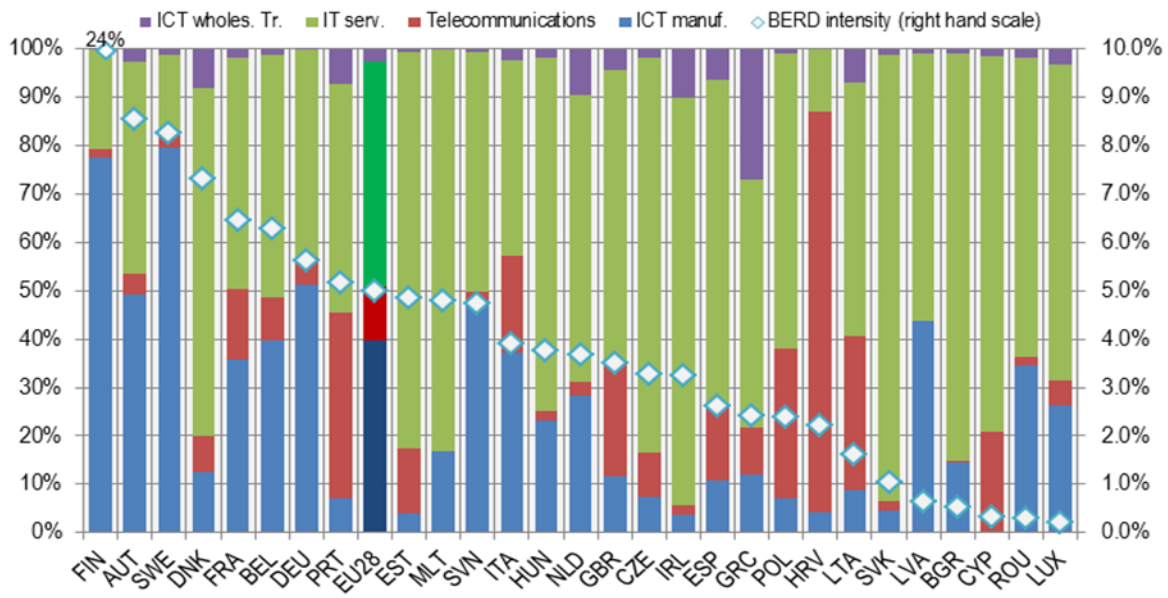
Left panel: billion euros; right panel: percentage values



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 28: ICT BERD in the EU Member States: Share on ICT value added (intensity ratio) and composition by industry, 2013

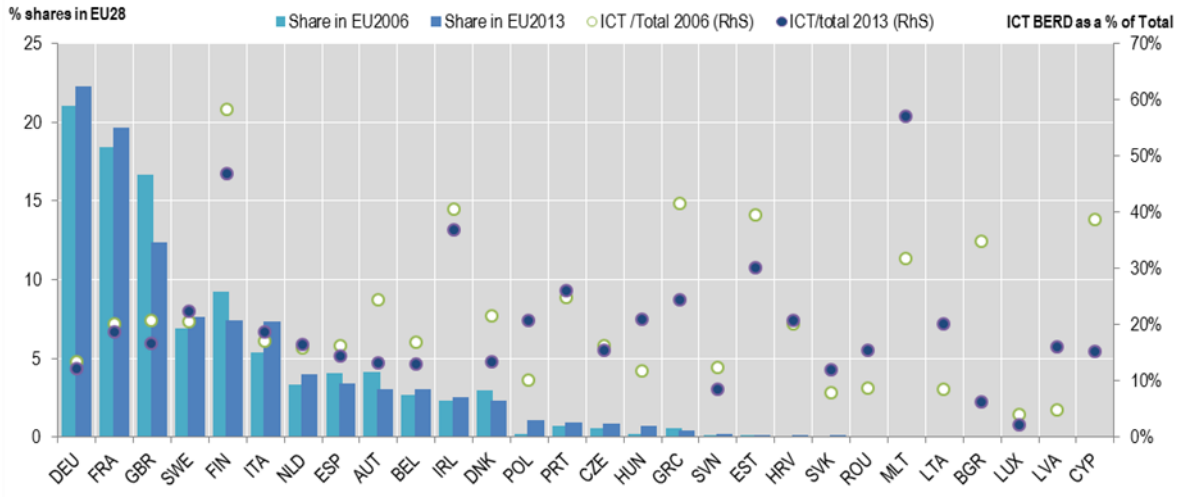
Percentage values



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Figure 29: Country shares in the EU28 ICT BERD and relative specialisation in ICT BERD*, 2013 and 2006*

Percentage values



Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

Key Facts 4: Specialisation Trends – Global Perspective (2006 – 2013)

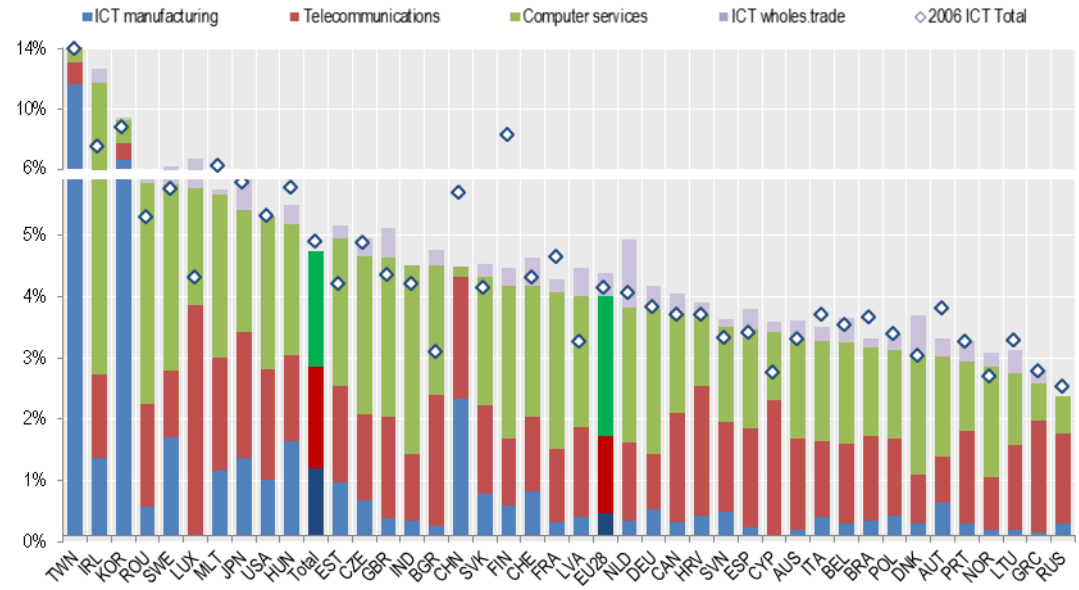
4.1 ICT Value Added Share in GDP

Specialisation in ICT, as portrayed by the sector's value added share over GDP, varies greatly across the 40 countries surveyed by PREDICT. In 2013, this share ranged from 10% or more in Taiwan, Ireland and Korea, to about 3% or less in Austria, Portugal, Norway, Lithuania, Greece and Russia. Although Japan and the USA are more specialised than the EU (see: Global Trends – Value Added), some small or medium-sized European economies are also highly specialised, including Ireland, Romania, Sweden, Luxembourg, Malta and Hungary (see: Benchmarking EU28 Member States - Value Added).

In most countries, the overall weight of the ICT sector in the economy has remained fairly stable over time: the major negative exceptions include Finland, due to the collapse of its mobile telecommunications manufacturing industry, and China, thanks to the tremendous development of other industries. In most cases, the stable share of the ICT sector in the economy went along with important changes occurring in industry composition, due to the rise of Computer services (see: Global Trends - Value Added).

Country ranking reflects shares of ICT Manufacturing and, increasingly, of Computer services. The weight of Telecommunications (usually 1-2% of GDP) is neutral. It tends to be slightly negatively related to the levels of GDP per capita and in past years was influenced by a number of factors, including waves of investment (and new services) and regulation/competition (for Europe, see: Benchmarking EU28 Member States - Value Added).

Figure 30: Value added of ICT industries as a percentage of GDP, all PREDICT economies, 2013 and 2006



Note: To allow for comparability, the ranking in this chart and 2006 totals are based on the operational definition of the ICT sector, which does not include the *Manufacture of magnetic and optical media* (ISIC rev.4 code 268) and the *wholesale of ICT products* (ISIC rev.4 code 465, reported for countries for which data are available). Data for Canada and Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

4.2 ICT Employment Share in Total Employment

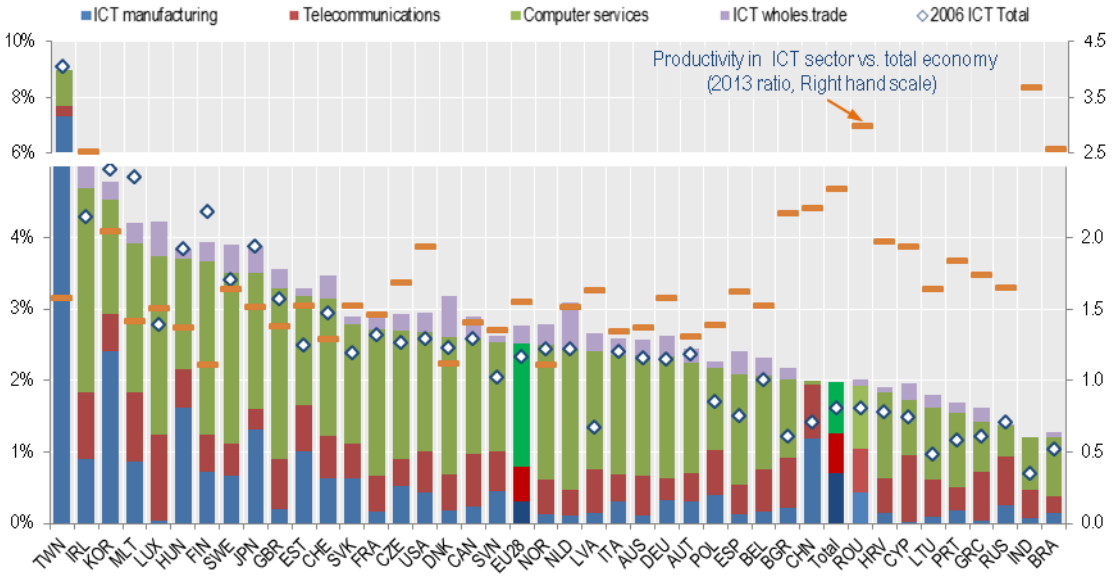
Across all PREDICT economies, the employment share of the ICT sector is lower than its weight in value added, mirroring labour productivity levels higher than the average (see: The EU28 and the World - Employment and Productivity, and, for Europe, Benchmarking EU28 Member States – Employment and Productivity).

The ICT sector employment share sector varies less between economies than it does in the case of value added. In the 40 countries surveyed by PREDICT, it ranged from 5% or more in Taiwan, Ireland and Korea, to about 2% or less in Brazil, India, Russia, Greece, Portugal, Lithuania and Cyprus. It was above 3% in the EU Member States of Ireland, Malta, Luxembourg, Hungary, Finland or Sweden, the UK and Estonia.

In general, the relative employment dimension of the ICT sector, given its size in terms of added value, is strongly influenced by the development of labour intensive activities related to Computer services (see: Global Trends - Focus on Emergent Activities in Computer Services).

During the period 2006-2013, the employment share of ICT activities increased. The largest relative growth took place in several EU economies with below-average levels: Greece, Portugal, Lithuania, Cyprus, Croatia, and Romania, but also in Bulgaria, Spain, Poland, Latvia, Slovenia, Slovakia, Estonia and Luxembourg. Growth in ICT employment share was also observed in the USA, Canada, the EU28 as a whole, China and India. In Japan, ICT employment share remained stable.

Figure 31: Employment in ICT industries as a percentage of total employment, all PREDICT economies, 2013 and 2006



Note: To allow for comparability, the ranking in this chart and 2006 totals are based on the operational definition of the ICT sector, which does not include the *Manufacture of magnetic and optical media* (ISIC rev.4 code 268) and the *wholesale of ICT products* (ISIC rev.4 code 465, reported for countries for which data are available). VA data for Canada and Japan refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

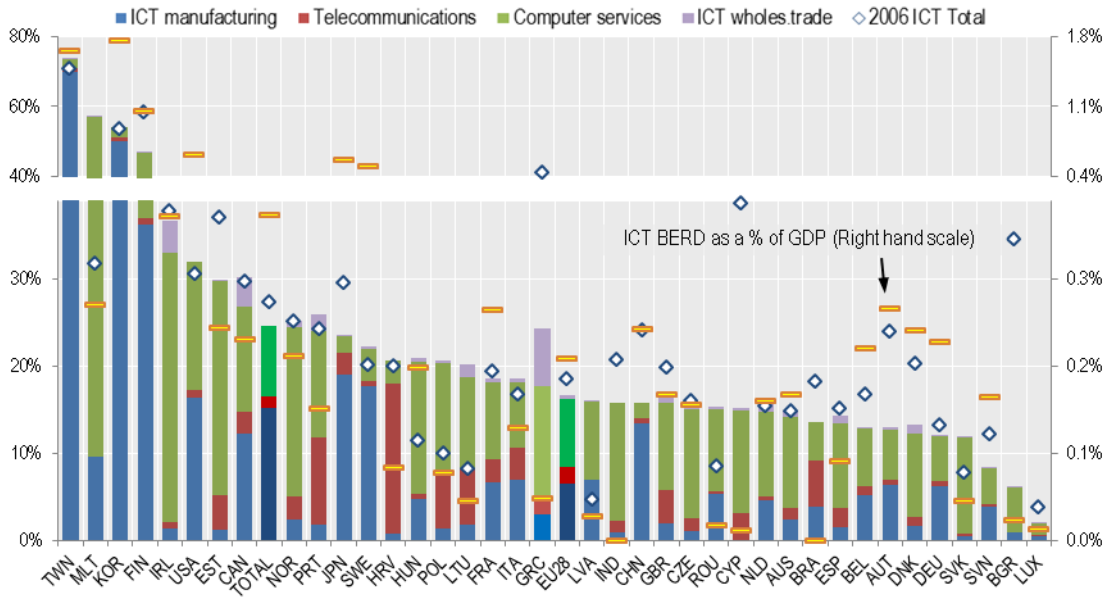
4.3 BERD Specialisation in ICT

In 2013, the ICT sector represented almost ¼ of total Business Expenditure in R&D (BERD) of the 40 countries surveyed by PREDICT, with a slightly decreasing pattern (see: Global Trends - BERD). In some small and medium-sized knowledge-intensive economies, ICT sector R&D accounts for 50% or more of their total BERD, and 1% of their GDP or more (Taiwan, Korea and Finland). In the USA and Japan, it accounts for about 0.6% of GDP (corresponding to about 30% and 23% respectively of their total BERD). Only a few small European countries present figures that can compare with these. The EU28 overall is less R&D-intensive – BERD performed by the ICT sector is only about 17% of total BERD and 0.2% of GDP.

Changes over time (2006-2013) in the relative weight of ICT BERD (and especially falls) vary very widely across countries, depending mostly on total BERD dynamics with notable gains in Malta, Hungary, Poland, Lithuania, Latvia, Romania and Slovakia, and falls in Estonia, UK, Belgium, Austria, Spain, Germany, Slovenia and Luxembourg. While in the USA and Canada ICT R&D shares stayed stable, these declined in Japan and the EU28 due to the contraction of BERD in ICT Manufacturing, and in India and China due to a very fast development of non-ICT BERD.

Most of the very limited R&D done in Telecommunication industries was carried out in equipment and device manufacturing. Finally, R&D in Computer services grew steadily in most economies, albeit at a slightly slower pace than value added.

Figure 32: R&D in ICT industries as a percentage of total BERD, all PREDICT economies, 2013 and 2006



Note: To allow for comparability, the ranking in this chart and 2006 totals are based on the operational definition of the ICT sector, which does not include the *Manufacture of magnetic and optical media* (ISIC rev.4 code 268) and the *wholesale of ICT products* (ISIC rev.4 code 465, reported for countries for which data are available). VA data for Canada and Japan refer to 2012 instead of 2013. BERD data for Brazil refer to 2008 instead of 2006 and to 2011 instead of 2013. BERD data for India and Russia refer to 2012 instead of 2013.

Source: JRC, PREDICT database (May 2016), available at: https://ec.europa.eu/jrc/en/predict/data

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